Title: Preferential Recycling/Rejection in CFBC/FBC Systems Using Triboelectrostatic Separation (DE-FG22-97PC97272)

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Abstract

Circulating fluidized bed combustion (CFBC) and fluidized bed combustion (FBC) with recirculation are widely used in the US for power generation. They have the advantage of fuel flexibility, and low NO_x and SO_x emissions. Typically, as partially combusted fuel is circulated in the system, only a split stream of this circulating stream is rejected, with the remainder recycled to the combustor. As a consequence, there is unburned carbon and partially used, valuable calcium hydroxide in the reject stream. If these useful materials in the reject stream can be recovered and sent back to the combustor, the efficiency of the system may be increased significantly and the equivalent emissions will be lower.

This project explores a new, innovative concept that using triboelectrostatic separation in CFBC/FBC systems to preferentially split recycle/reject streams based on material compositions of the particles. Triboelectrostatic separation technology has most of the required characteristics for such a separator including in-line installation, dry pneumatic particle handling, low processing cost, minimum equipment addition, and efficient fine particle separation. The objective of this 12 month, innovative concept project is to examine the separability of the constituents and ash in a CFBC/FBC recirculation stream at elevated temperatures.

Various separator designs were evaluated and tested in the past six months. First, a design of short residence time, jetting configuration, and batch mode was used to test utility fly ash - unburned carbon separation. Detailed studies of the separation efficiency and controlling parameters were conducted to understand the particle - particle separation under various material and operational conditions. A long residence time, laminar flow, continuous separator was then built to test the design in continuous operation mode. With the experience and improved understanding of the separation system, a high speed, turbulent, continuous separator was also designed and tested. It has shown great potential for high throughput and high efficiency. Because flow conditions within the existing CFBC/FBC systems are more likely to be turbulent and high speed, the high speed design is likely to be a favored candidate for our purpose.

The results for PC fly ashes indicated variation in performance for samples from different power plants, different units with a power plant. The performance of each sample seemed to be dependent on the

characteristics of the sample, for instance, the size distribution of unburned carbon and ash. These data will further be analyzed by an evaluation method that can characterize the sample performance independent of the separator used.

Our preliminary separation tests using a utility FBC reject material indicated that carbon content can be greatly reduced in the reject stream (from 7% to 0.5%), and enriched in the recycle stream (up to 22%). These results from our laboratory batch separator demonstrated great potential for the technology and the need for more experiments.

The work for next six months will start with the inclusion of heating and temperature control to the separation system to study the effect of temperature on separation. More experiments will be performed to show the percentage of carbon and other useful constituents can be recovered from CFBC/FBC reject material.

List of Papers and Presentations

Heng Ban, Tianxiang Li, Mike Etchells, Kimberly A. Aubrey, and John M. Stencel, Triboelectrostatic Separation Technology: Size and Size Distribution Influence in Coal Combustion Fly Ash, Proceedings, International Ash Utilization Symposium, 1997, pp. 451 - 458.

John M. Stencel, Heng Ban, Tianxiang. Li, James K. Neathery and John L. Schaefer, Dry Electrostatic Separation of Carbon from Coal Fly Ash, The Proc. of Second Conference on Unburned Carbonaceous Material On Utility Fly Ash, March 5-6, 1996, Pittsburgh, PA, USA, pp. 159-177.

Tianxiang Li, John L. Schaefer James K. Neathery, Heng Ban, Dennis Finseth and John M. Stencel, Influence of Carbon on Charge Transfer and Exchange in Fly Ash, Annual Meeting of American Chemical Society, 1998 (submitted for presentation).

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